THE OPTICAL CHARACTERS OF SOME MICAS.

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For the determination of the true characters of the micas—a class of minerals rapidly gaining in importance—a knowledge of their optical characters is almost as necessary as is that of their chemical composition. The optical is certainly the most ready method of determination. The investigation here recorded is but a partial one, and it is hoped that in the future it may be extended so as to include most of the American micaceous minerals. The measurements have been made for the most part upon minerals which have never been optically examined, and are chiefly American. A few foreign species have been introduced for comparison. The micas examined are largely those in the collection of the Academy. Others were either in the writer's collection or have been kindly given him by friends. The source from which each specimen has been obtained is noted in the tables given below.

The polariscope used was made by Queen & Co., of this city, and was described before this Section at its meeting last May. It reads to within 30′. The figures given below represent the mean apparent optic-axial angular divergence for white light. As the angle is somewhat different in different specimens and sometimes even in different portions of the same plate, the figures must be regarded as only approximate. In each case they represent a mean of a number of separate measurements, and collectively are the result of over 1600 such measurements.

Phlogopite.

1. Sussex Co., N. Y. Hexagonal crystals, yellow, transparent. (Acad. Nat. Sci.) 6°.
2. Burgess, Ont., Can. Clear brown. (A. N. S.) 6°45′.
3. N. Shore of Rideau Lake, Burgess, Can. Angle varies in same piece. Clear brown. (J. Willcox.) 6°–12°
4. Hammond, St. Lawrence Co., N. Y. Clear yellow. Hyperbolas closer in the centre than they are near the edges of the crystals. Crystals are sometimes uniaxial in the centre and biaxial at each end, while the plane of the optic axes at

one end is at right angles to that at the other end, viz.:
One crystal had angle at centre, 7°30′, angle at edge, 11°15′. (A. N. S.) 10°40′.

5. Jefferson Co., N.Y. Brownish-yellow. (A. N. S.) 11°21′-12°50′.
6. Vrooman's Lake, Jefferson Co., N. Y. Wine-yellow. (A. N. S.) 12°45′.
7. Oxboro', Jefferson Co., N. Y. Light yellow. (A. N. S.) 13°12′.
8. Ottey Lake, Burgess, C. W. Brown hexagonal crystals. (W. W. Jefferis). 13°20′.
   A crystal from the same locality (J. Willcox) gave for the outer part of crystal, 13°41′; centre of crystal, 11°23′.
9. Calumet Is., Canada. Greenish-yellow, transparent. (A. N. S.) 13°20′-14°18′.
10. New Hampshire. Reddish-brown, similar to Darby Biotite; nearly uniaxial in thin plates. 13°10′–17°.
11. Sparta, N. J. Dark brown; by reflected light nearly black. 14°20′.
12. Vrooman's Lake, Jefferson Co., N. Y. Clear pale yellow. Some crystals show identical phenomena with those from Hammond, St. Lawrence Co. 14°24′.
13. St. Denis. "Plumose mica:" brown: thick, nebulous hyperbolas. 14°30′.
14. Warwick, N. Y. Dark green; cleaving into rhombs; often mistaken for Biotite. 14°52′.
15. Pope's Mills, St. Lawrence Co., N. Y. Deep reddish-brown. (W. W. Jefferis.) 15°.
16. Vesuvius. Black by reflected light, dark reddish-brown in thin plates. With icespar: very opaque. (A. N. S.) 15°±.
17. Clark's Hill, St. Lawrence Co., N. Y. Brown. (W. W. Jefferis.) 15°10′.
18. Kennett Square, Del. Co., Pa. Brown; in limestone. 15°20′.
19. Edwards, N. Y. Pearly white. (W. W. Jefferis). 15°30′.
20. Rossie, St. Lawrence Co., N. Y. Yellowish-brown. (A. N. S.) 15°52′.

21. S. Burgess, Can. Large brown crystal, purple on edges. (A. N. S.) 16°38′.
22. Clark's Hill, near Rossie, N. Y. Brownish-yellow. (A. N. S.) 16°45′.
23. Clark's Mills, N. Y. Light brown, transparent: (probably identical with Nos. 17, 20, 22). (A. N. S.) 17°.
24. Canada. Asteriated Phlogopite. 19°.
25. S. Burgess. Clear yellow-brown. (A. N. S.) 19°.
26. Burgess, C. W. Yellowish-brown crystals, with secondary cleavage along diagonal. (W. W. Jefferis). 20°.
27. Rossie, N. Y. Black by reflected, reddish-brown by transmitted light. (A. N. S.) 21°13′.
28. Vesuvius. Black, crumbling, very opaque, mixed with black hornblende. (A. N. S.) 21°20′±.
29. Burgess, C. W. Asteriated, not transparent, silvery-brown. (A. N. S.) 21°35′±.
30. Rossie, N. Y. Black by reflected, dark brown by transmitted light. Contains apatite. (A. N. S.) 22°.
31. Chester Co., Pa. Feebly asteriated; locality wrong?; probably from Rossie, N. Y. (A. N. S.) 23°15′.
32. Alamutchie, N. J. Clear reddish-brown. (Frankl. Inst.) 30°5′.
33. Van Arsdale's Quarry, Bucks Co., Pa. Red-brown; with graphite, etc. 34°.

Biotite.

1. Easton, Pa. White, silver mica. 2°±.
2. Antwerp, N. Y. Greenish-white. 0°.
3. Culsagee, N. C. White. 0°.
4. Vesuvius. White. 0°.
5. Darby, Del. Co., Pa. Deep red. 0°.
6. Delaware Co., Pa. Crystal in muscovite; black by reflected, brownish-red by transmitted light. 5°±.
7. Scotland. Brown. 0°.
8. Rossie, N. Y. Brown. 0°.

Probably several of these Biotites have an angle of 1°–2°.

Lepidomelane.

Arendal, Norway. Black; uniaxial.	0°.
Frankford, Phila. Black; uniaxial.	0°.

Muscovite.

1. Brunswick, Me. Bright green scales. (A. N. S.)	56°25′.
2. Pennsbury, Pa. (A. N. S.)	56°50′.
3. Vesuvius. With adularia. (A. N. S.)	59°20′.
4. Dutton's Mills, Del. Co., Pa. (J. M. Cardeza.)	60°.
5. St. Lawrence Co., N. Y. Greenish-white, plumose radiated crystals, showing Airy's spirals. (A. N. S.)	60°40′.
6. Darby, Phila., Pa. Small scales in gneiss.	61°10′.
7. Siberia. (A. N. S.)	63°.
8. Germantown, Phila. Smoky brown, clear crystals.	63°4′.
9. Plainfield, Conn. Margarodite. Contains 5 p. c. of water.	63°15′.
10. Poorhouse, Del. Co., Pa.	63°47′.
11. Germantown, Pa.	64°23′.
12. Germantown, Pa. Containing enclosed crystals of a black, uniaxial mica.	64°30′.
13. Frankford, Pa. In hornblende rock: in calcite, with fluorite and epidote. (T. D. Rand).	64°50′.
14. Falls of Schuylkill, Phila. In hornblende rock.	65°.
15. Cumberland, England. "Nacrite." (A. N. S.)	65°.
16. Goyaz, Brazil. (A. N. S.)	65°50′.
17. Brandywine Hundred, Del. Containing magnetite markings. After heating until it whitens, it has an angle of 49°.	65°–67°30′.
18. Litchfield, Me. (A. N. S.)	65°–68°34′.
19. Portland, Conn.	66°.
20. Southern Colorado. Identical with mica of Pennsbury, Pa., and Brandywine Hundred, Del., having magnetite markings.	66°7′.
21. Grafton, N. H.	66°12′.
22. Chandler's Hollow, Del. (J. M. Cardeza.)	66°40′.
23. Black Hills, Wyoming. (A. N. S.)	66°48′.
24. Zinnwald, Bohemia. (A. N. S.)	66°51′.
25. Buncombe Co., N. C. (A. N. S.)	67°30′.

26. Germantown, Pa. Large silvery plates.	67°30′.
27. Dixon's Quarry, Del. Pale green.	67°45′.
28. Connecticut. Green scales. (A. N. S.)	67°45′.
29. Georgetown, Col.	68°.
30. Upland, Del. Co., Pa. Pale green. (J. M. Cardeza.)	69°19′.
31. Germantown, Pa. Pale green.	69°38′.
32. Chester Co., Pa. (A. N. S.)	69°45′.
33. Westchester Co., N. Y.	70°14′.
34. Fabyans, White Mountains, N. H.	71°30′.
35. Glacier of the Aar, Switz. (A. N. S.)	74°10′.
36. Trumbull, Conn. Margarodite.	75°.
37. Paris, Me. Rose-color. (A. N. S.)	76°15′.

Where not otherwise indicated, the above muscovites are of a clear yellowish-brown tint.

Lepidolite.

1. Altenberg, Saxony. With Pycnite; sometimes distorted. (A. N. S.)	31°.
2. Zinnwald, Bohemia. Often very irregular. On different parts of the same piece the angle varies from 34°30′ to 51°30′. (A. N. S.)	49°30′
3. Paris, Me. Much distorted; several axes. (A. N. S.)	60°±.
4. Middletown, Conn.	66°.

Talc.

1. Lafayette, above Manayunk, Pa. Exfoliating: fan-shaped crystals: images much distorted.	12°40′.
2. Lafayette, Pa. Clear.	15°.
3. Lafayette, Pa. Foliated talc; distorted images.	15°.
4. Harford Co., Md. White.	15°.
5. Shetland Is. Clear pale green, sometimes nearly uniaxial.	17°.

Pyrophyllite.

Westana, Sweden.	106°51′.

Serpentine.

Chrysotile from Chester Co., Pa., shows strong double refraction when the fibres make an angle of 45° with the plane of polariza-

tion of the instrument. Bissectrix apparently parallel to the fibres. Probably orthorhombic. Common serpentine and Williamsite show no double refraction.

Damourite.

1. Culsagee, N. C. In scales: analyzed by Koenig. (F. A. Genth.)	66°17′±.
2. Unionville, Pa. "Emerylite:" irregular hyperbolas. (A. N.S.)	69°35′±.
3. Unionville, Pa. On corundum.	72°.
4. Unionville, Pa. "Corundellite." (J. M. Cardeza.)	72°.
5. Horsjoberg, Sweden. (T. D. Rand.)	72°25′.
6. Chester Co., Pa. "Margarite:" irregular, showing sometimes four hyperbolas. (A. N. S.)	72°30′.
7. Haywood, N. C. "Altered from corundum." (F. A. Genth.)	74°.
8. Unionville, Pa. Analyzed by Sharpless. (F. A. Genth.)	74°10′.
9. Unionville, Pa. Analyzed by Koenig. (F. A. Genth.)	74°15′.
10. Newtown, Conn. With Cyanite.	74°24′.
11. Newlin, Chester Co. "Margarite." (A. N. S.)	75°50′.

It is evident that the minerals labelled Emerylite, Corundellite, Margarite, etc., are all Damourite.

Euphyllite.

1. Chester Co., Pa. (A. N. S.)	37°–40°.
2. Unionville, Pa. "Original." (F. A. Genth.)	36°30′.

A thicker piece in which the hyperbolas were very dim, had an angle of 45°±.

This result is interesting, as the optical angle given by Silliman is 71°.

Cookeite.

Paris, Me. In small scales.	42°40′.

Vermiculite.

1. E. Nottingham, Chester Co., Pa. *Hallite.* In green crystals: uniaxial. 0°.

2. Cecil Co., Md., Magnesia Quarry. *Hallite.* Contains enclosed arrow-shaped crystals like Hallite: uniaxial. 0°.

3. Chester Co., Pa., Brown's Quarry. Uniaxial. (T. D. Rand.) 0°.

4. Macon Co., N. C. *Maconite.* In brown scales; uniaxial or with a divergence of 1°±. (F. A. Genth.) 1°±.

5. Mineral Hill, Del. Co., Pa. Pale green. (A. N. S.) 19°.

6. Lenni, Del. Co., Pa. Brown and green; sometimes a very small optic angle occurs. 19°–20°.

7. Culsagee, N. C. *Culsageeite.* Yellowish-brown: variable angle. Sometimes the angle varies as different portions of the same piece are moved into the field. One piece gave 9°, and another was nearly uniaxial. The angle given is the most constant one. 20°±.

8. West Chester, Pa. *Jefferisite.* Variable angle: a specimen gave at one part 16°30′, and at another 25°, the latter being the most distinct; a very thin piece gave 11°30′, and a thicker piece 27°20′. Apparently the optic-angle increases with the thickness of the plate. Some good specimens gave 22°, 25°, and 28°; mean angle probably, 26°±.

9. Lafayette Soapstone Quarry, Montgomery Co., Pa. Brown scales in chlorite slate: constant angle 32°–36°30′; mean, 34°±.

10. Germantown, Phila. Brown plates in hornblende rock. Optic-angle constant within 31°20′–39°30′; the most constant angle is 37°±.

It is very probable that, as suggested by Prof. Cooke, the variation in the optic-angle of the Vermiculites is caused by twinning

Ripidolite.

1. Patterson's Quarry, Newlin Township, Chester Co., Pa. Irregular green plates; with corundum; inclination of bissectrix to normal to cleavage plane, 5°30′: optic-axial divergence variable on the same plate on account of twinning, varying from 50° to 59°30′. (T. D. Rand.) Generally as given. 59°30′.
2. West Chester, Pa. Green plates; inclination of bissectrix 10°: axial divergence, 78°30′.
3. Brinton's Quarry, Chester Co., Pa. Fine clear green plates; inclination of bissectrix, 12°30′. $\rho > \nu$. Axial divergence, 82°.
4. Dudleyville, Ala. Pale rose-color; on chromite. Inclination of bissectrix, 16°. $\rho > \nu$. (F. A. Genth). 94°15′.

In all of these, double refraction is feeble compared with that of Muscovite. It is observed that the inclination of the bissectrix to the normal to the cleavage plane increases with the divergence of the optic axes.

Prochlorite.

Brewster, N. Y., Tilly Foster Mine. Uniaxial. 0°.

Margarite.

1. Cullakanee, N. C. White, "altered from corundum." Irregular figures. (F. A. Genth.) 110°±.
2. Chester, Mass. Rose-color, with corundum; irregular, in some places showing four hyperbolas; one piece gave 89°30′. 112°45′.
3. Dudleyville, Ala. White, clear; inclination of bissectrix, 1°±. (F. A. Genth). 122°15′.
4. Cullakanee, N. C. White, "altered from Zoisite." Inclination of bissectrix to normal to cleavage plane, 2°±. (F. A. Genth.) 124°.

The large optic-axial divergence of Margarite readily distinguishes it from Damourite and other micas which resemble it. If further observations agree in showing that the bissectrix is inclined to the normal to the cleavage plane, it will show that Margarite is *Monoclinic* and not Orthorhombic as has been supposed.